



# **Materials Research & Education: Looking Back, Racing Forward**

**Zakya H. Kafafi**

**Director, Division of Materials Research (DMR)  
National Science Foundation**

**Where are we?**



**Where are we going?**



**MRS Fall Meeting  
December 1, 2008**

# Division of Materials Research (DMR)

## OFFICE of the DIVISION DIRECTOR



Zakya Kafafi  
Division  
Director



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(Acting)



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Hopkins Senior  
Staff Associate



Neila Odom-Jefferson  
Operations Specialist  
STB Student  
Secretary



## Manager



Carol Savory-Heflin  
Manager

## Program Support



Denese Logan  
Analyst



Bill Daniels  
Specialist



Deborah E. Dory

## Administrative Unit

## Senior Program Assistants



Renee Ivey



Shirley Millican



Bernie Trumble

## Program Directors

### Condensed Matter & Materials Theory (CMMT)



Daryl W. Hess  
Condensed Matter Physics (CMP)



Michael A. Lee  
Kent State U.



Mark Anderson



Wendy Fuller-Mora



Roy V. Smith



Oscar O. Bernal



Udo Pernisz  
Dow Corning

### Solid-State & Materials Chemistry (SSMC)



Dave L. Nelson  
Polymers (POL)



George Washington



Andrew J.  
Lovinger



Freddy Khoury

### Biomaterials (BMAT)



David A. Brant



Joseph A.  
Akkara



Satya G. Kumar  
Kent State U.

### Ceramics (CER)



Lynnette D. Madsen  
Electronic Materials (EM)



LaVerne D. Hess



Z. Charles Ying

### Metals (MET)



Hanu D. Chopra  
SUNY



Bruce A. MacDonald

### Materials Research Science & Engineering Centers (MRSEC)



Maija M. Kukla



Thomas P. Rieker



Rama Bansil  
Boston U.

### Office of Special Programs (OSP)



Caroline E. Hult



Uma Venkateswaran

### Instrumentation for Materials Research (IMR)



Charles Bouldin



Guebre X. Tessema

### National Facilities (NAF)

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Neila Odom-Jefferson  
Operations Specialist



VACANT  
Division  
Secretary



My Di Le  
STEP Student

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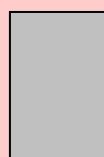
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Joseph A.  
Akkara



David A. Brant



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### Ceramics (CER)

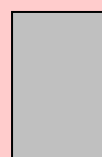


Lynnette D.  
Madsen

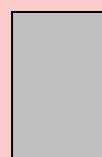
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Daryl W.  
Hess



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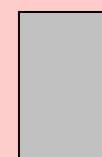
Oscar O. Bernal



Wendy Fuller-Mora



Udo Pernisz  
Dow Corning



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### Electronic and Photonic Materials (EPM)



LaVerne D. Hess



Z. Charles Ying

### Instrumentation for Materials Research (IMR)



Charles Bouldin

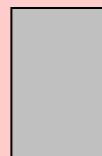
### Materials Research Science & Engineering Centers (MRSEC)



Thomas P. Rieker



Rama Bansil  
Boston U.



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### Metallic Materials and Nanostructures (MMN)



Harsh D. Chopra  
SUNY



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### National Facilities (NAF)



Guebre X. Tessema

### Office of Special Programs (OSP)



Danielle Finotello



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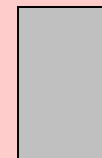


Freddy Khoury

### Solid-State & Materials Chemistry (SSMC)

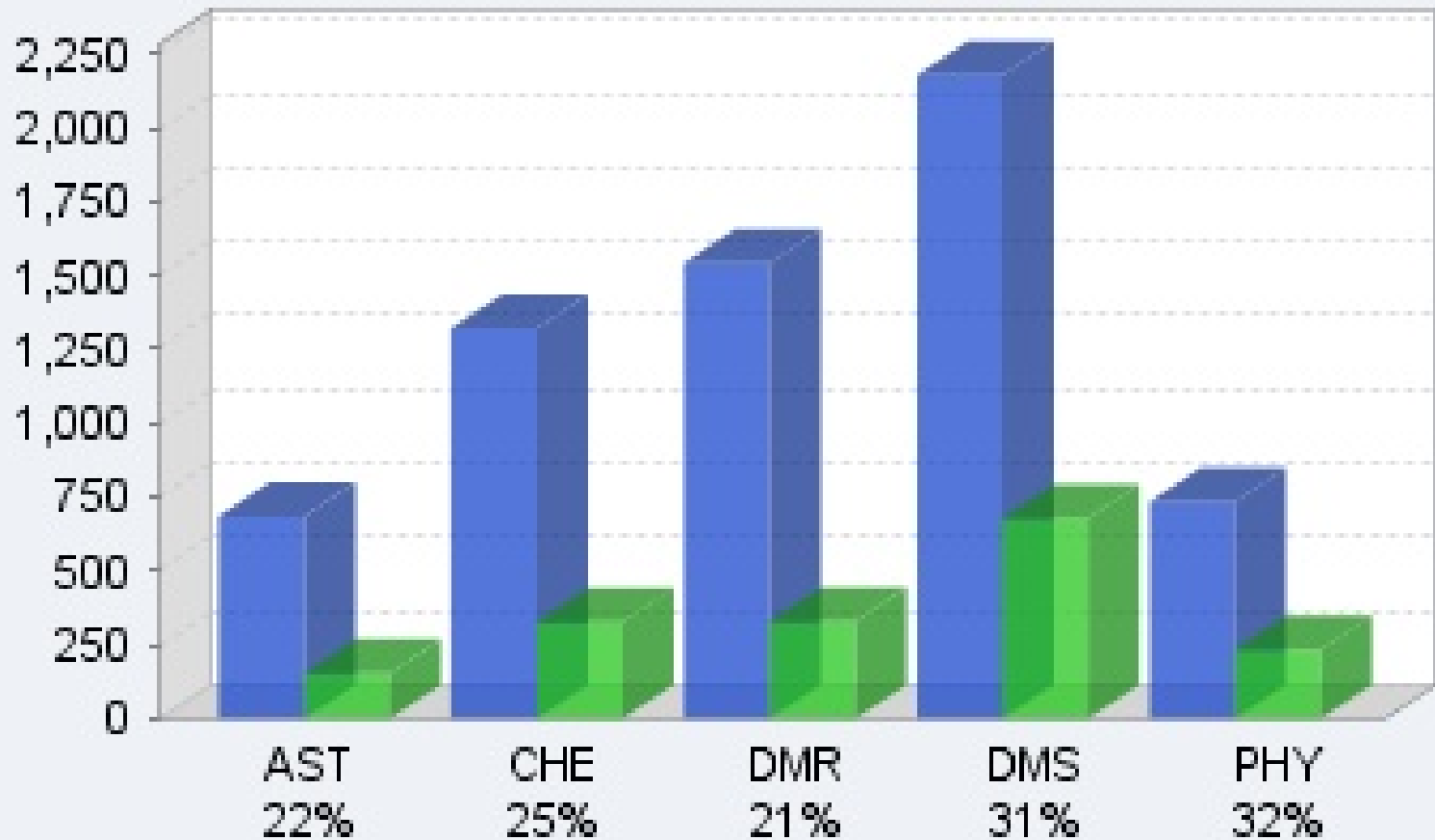


Linda Sapochak



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## FY 2008 Overall MPS Funding Rate: 27%



### DMR

2008	1,917	440	23%
2007	1,594	405	25%
2006	1,685	385	23%
2005	1,658	366	22%
2004	1,618	428	26%
2003	1,589	561	35%

■ Actions ■ Awards

### MPS

2008	6,470	1,720	27%
2007	6,177	1,849	30%
2006	6,275	1,736	28%
2005	5,795	1,587	27%
2004	5,673	1,603	28%
2003	5,528	1,708	31%

# FY 2009 Budget Request by Division

## Mathematical and Physical Sciences Funding

(Dollars in Millions)

	FY 2007 Actual	FY 2008 Estimated	FY 2009 Request	Change over FY 2008 Estimated	
				Amount	Percent
Astronomical Sciences	\$215.39	\$217.86	\$250.01	\$32.15	14.8%
Chemistry	191.22	194.22	244.67	50.45	26.0%
Materials Research	257.27	260.22	324.59	64.37	24.7%
Mathematical Sciences	205.74	211.79	245.70	33.91	16.0%
Physics	248.47	250.52	297.70	47.18	18.8%
Multidisciplinary Activities	32.64	32.70	40.00	7.30	22.3%
Total, MPS	\$1,150.73	\$1,167.31	\$1,402.67	\$235.36	20.2%

Totals may not add due to rounding.

**NSF:  
\$6.854 B,  
+13.0%**

# Racing Forward

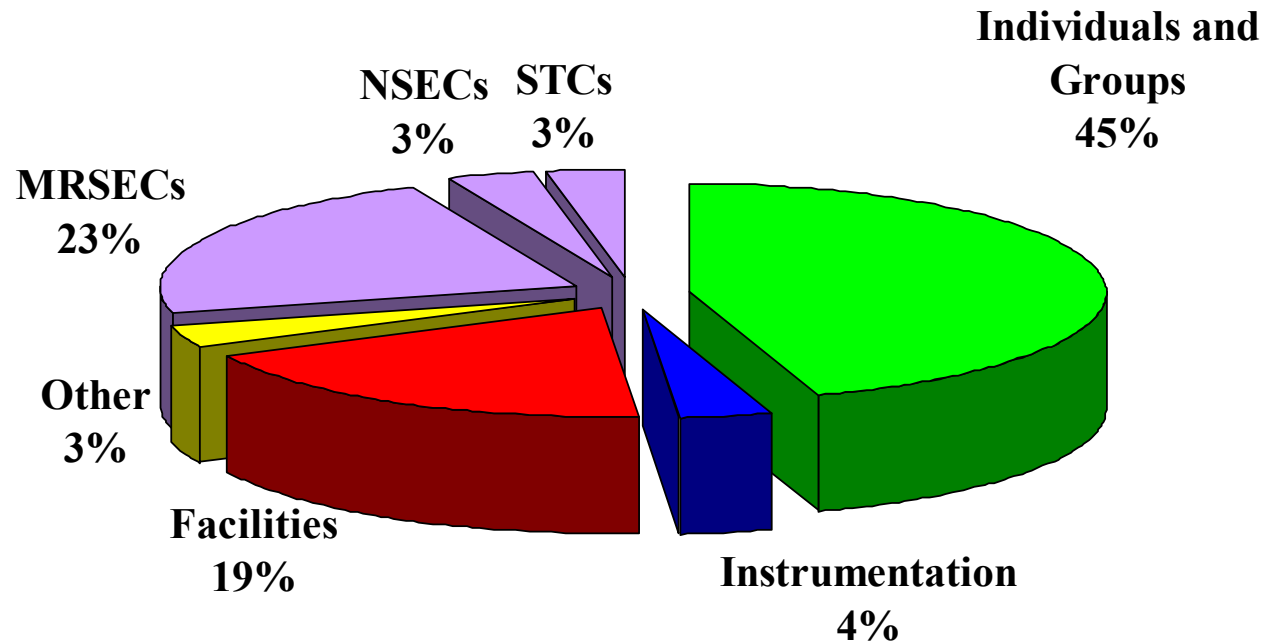
**Substantial increase in budget will allow DMR to:**

- Increase # and size of PI grants
- Start new centers & institutes to enable focus on transformative, interdisciplinary, global materials research & education effort
- Expand investments in workforce development, especially at the junior rank while broadening participation for women, minorities and scientists with disabilities
- Develop new educational & outreach activities



# DMR Support for Materials Research & Education

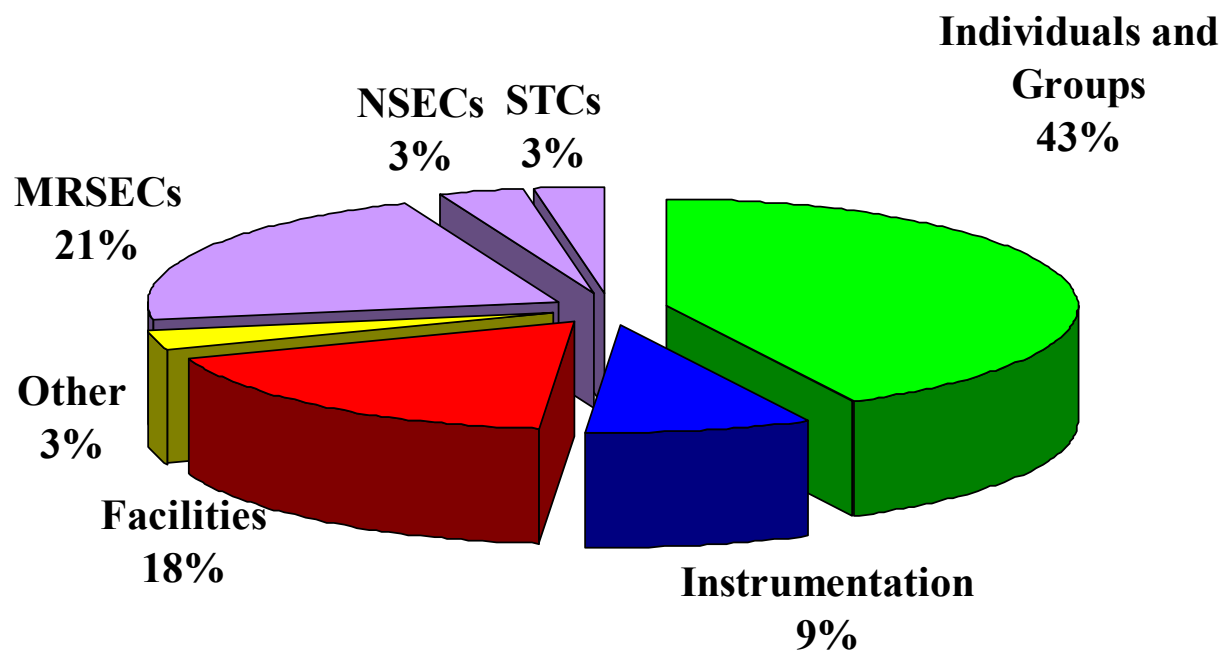
(\$259.4 M in FY08)





# DMR Budget\* for Materials Research & Education

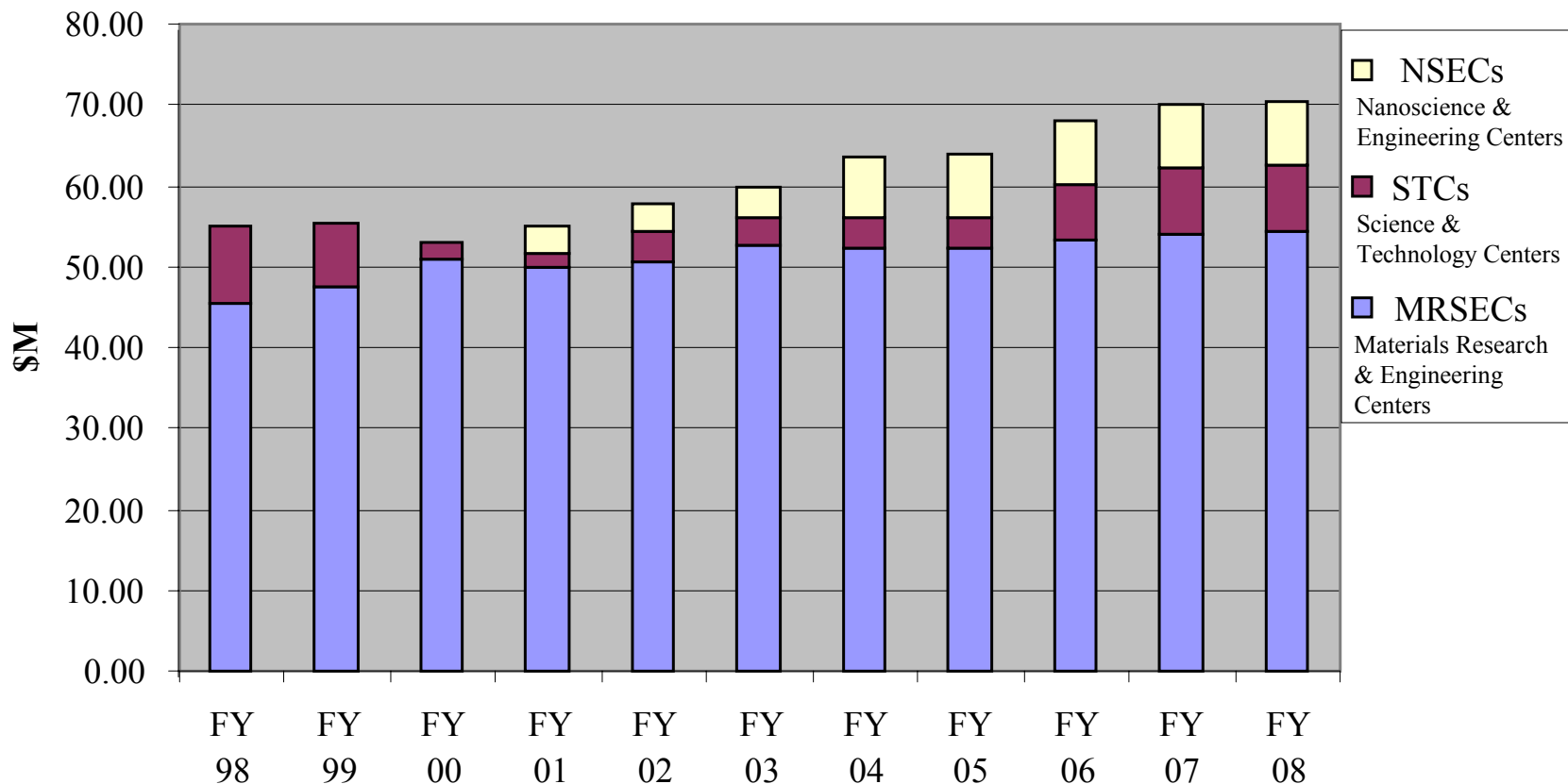
(\$274.0 M in FY 2008)



\* Includes \$14.6 M MRI



# DMR Research and Education Centers



# Materials Research Science and Engineering Centers

## FY 2008 Competition

- 31 centers nationwide
- 14 Awards - National investment in timely and important areas such as sustainable energy, bio- and soft-materials, nanotechnology, next-generation electronics and photonics
- Largest turnover in the history of the program
  - 5 awards to institutions that have *not* had a MRSEC
  - 9 MRSECs successfully re-competed
  - 4 existing MRSECs being phased-out

## Where are we going?\*

### *Next MRSECs (> one IRG):*

- Expand activities to international arena
- Develop cyber-enabled infrastructure between MRSECs, PREMs and other centers

# Materials Research Science and Engineering Centers (MRSECs)

**Where are we going?\***

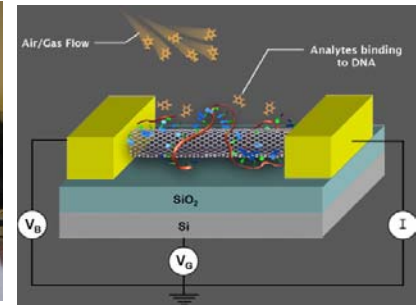
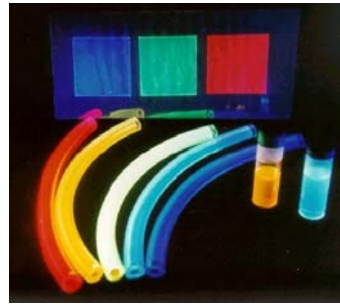
## **MIRACLE Centers**

Launch a new type of cyber-enabled centers (one IRG) focused on *Materials Innovative Research and Creative Learning Experience*

\* Based on the recommendations of the NAS study on MRSECs

# Partnership for Research & Education in Materials (PREM)

....broaden participation in materials research and education by stimulating the development of *long-term, collaborative partnerships between minority serving institutions and DMR-supported groups, centers and facilities.*



- 10 PREMs currently funded ~ 500k/year for 5 years (<http://mrsec.org/prem/>)
- **New PREM competition: Proposals Due March 5, 2009**  
**Solicitation: NSF 09-518**
- Expanded to **institutions primarily serving women and people with disabilities**
- Partner with DMR supported centers, groups or facilities



# Stewardship: DMR Facilities

\$ 42M ~ 6000 users annually



~290 Users



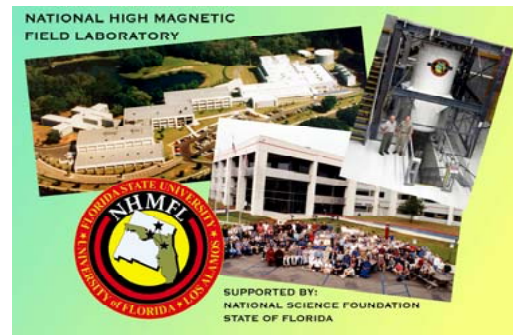
536 users



~480 users

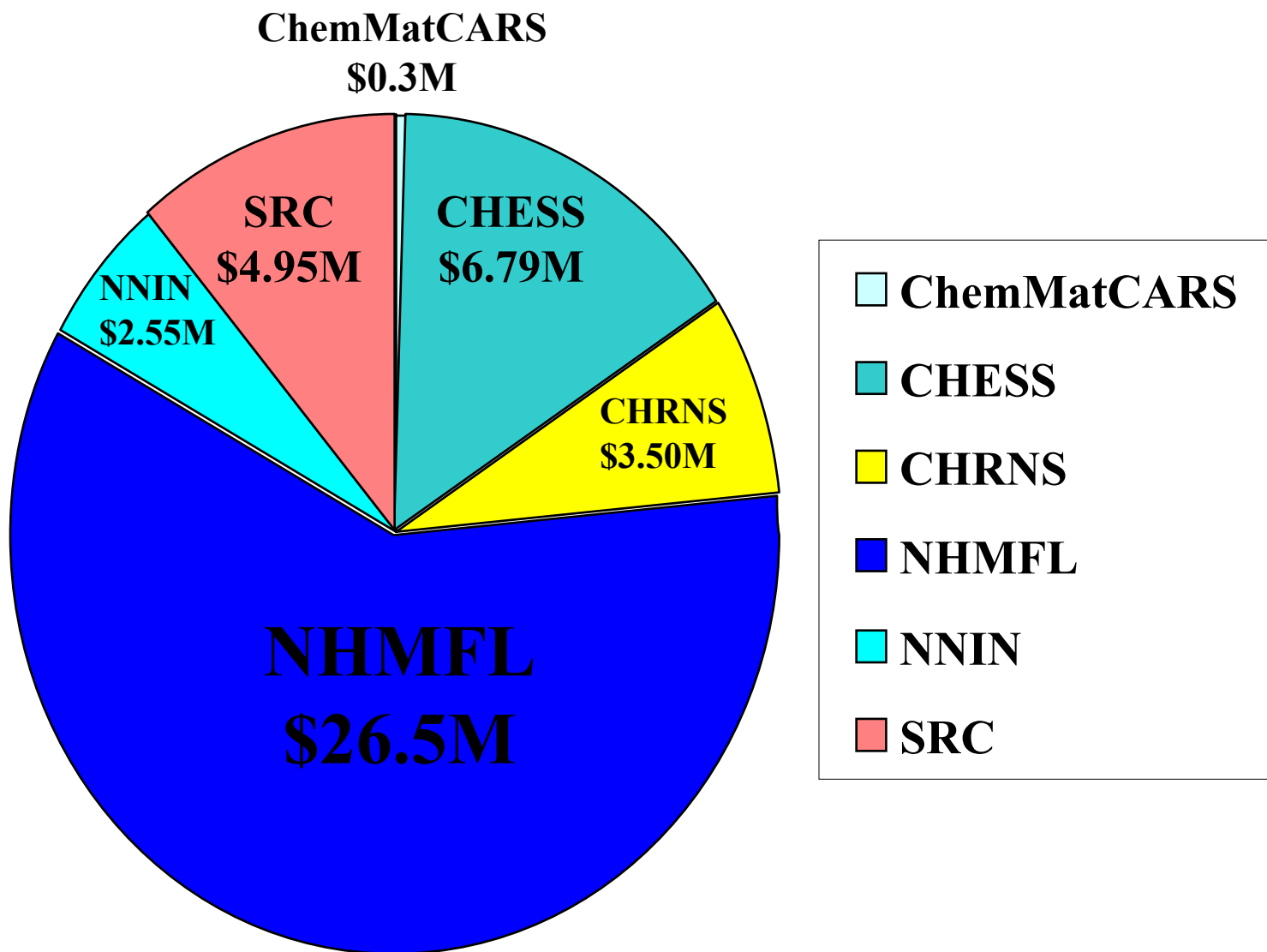


3564 users



~1000 Users

# FY 2008 Budget Distribution for Facilities



# DMR Facilities – Major Challenges

*Facility operating costs are borne by DMR*

## I. Stewardship of the NHMFL

- DMR currently provides ~95% of NSF funding
- Serving an increasingly broad user community

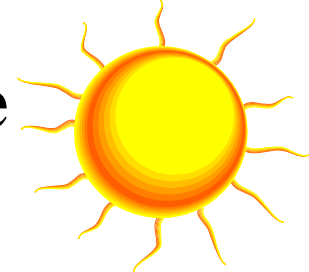
**Partnership is essential !**

## II. Stewardship of Future Light Source Facilities? Future of University-Based Synchrotron Facilities?

*Light Source Panel Report  
November 6, 2008*



# New CHE-DMR-DMS SOLAR Initiative for FY 2009



- At least three co-PIs, providing expertise in chemistry, materials research, and mathematical sciences
- Two-stage proposal preparation and review process to reduce the burden on the communities

## What is MPS ROLE?

- Capitalize on the unique strengths of our disciplinary communities
- Use new interdisciplinary modalities by bringing together mathematicians, chemists, and materials researchers, focusing on interdisciplinary synergy and aiming for transformative breakthroughs
- Focus on new fundamental chemical approaches, materials design, physical concepts, and mathematical algorithms



# ***The Energy in Sunlight***

$1.2 \times 10^5$  TW delivered to Earth  
36,000 TW on land (world)  
2,200 TW on land (US)

Annual Human Production of Energy  
 $4.6 \times 10^{20}$  Joules  
1 hour of sunlight



Earth's  
Ultimate Recoverable Resource  
of oil  
3 Trillion (=Tera) Barrels  
 $1.7 \times 10^{22}$  Joules  
1.5 days of sunlight

## **FUNDING POTENTIAL**

- Anticipated 3-yr duration (possible renewal for 3 more yrs)
- \$5M initial investment in FY2009
- Doubling in FY2010 and tripling in FY2011
- 3-10 awards anticipated in FY2009
- Potential for expansion in future years
- Potential to grow and include other sources of renewable energy in future years

## What's inside

- ▶ Homepage
- ▶ About the IMA
- ▶ What's Happening
- ▶ Programs/Activities
- ▶ Publications
- ▶ Visitor Information
- ▶ People
- ▶ Application Forms
- ▶ Talk Materials
- ▶ Video
- ▶ Program Solicitation
- ▶ Room Reservations
- ▶ NSF Math Sci Insts
- ▶ Program Feedback
- ▶ Join our Mailing Lists

## IMA Special Workshop:

# Scientific Challenges in Solar Energy Conversion and Storage

*November 1, 2008*

### Organizers:

**Eray Aydil** Chemical Engineering and Materials Science, University of Minnesota

**Weinan E** Mathematics and Program in Applied and Computational Mathematics, Princeton University

<a href="#">Schedule</a>	<a href="#">Participants</a>	<a href="#">Program Application</a>	<a href="#">Feedback</a>
<a href="#">IMA Live Streaming and Webcasting</a>			<a href="#">Maps</a>
<a href="#">Abstracts and Talk Materials</a>			<a href="#">Dining Guide</a>
<a href="#">University of Minnesota Press Release</a>			

### Description:

The Institute for Mathematics and its Applications (IMA) in conjunction with the National Science Foundation Division of Math Sciences is organizing a one-day workshop on the new initiative called **SOLAR** [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=503298](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503298).



# A Vision for a Global Materials Network

- Connects diverse stakeholders (people, academic institutions, professional societies, government agencies, etc.) interested in materials research and education
- Based on joint ownership, mutual benefit, and universal participation
- Its mission is to serve the needs of materials stakeholders worldwide



*Microstructured Optical Fibers as High Pressure Microfluidic Reactors, P. Sazio (UK), J. Badding (Penn State) et al, Science, March 2006*

# A Global Materials Network

## Where we are

### I. Partnerships with funding organizations in:

#### *- Europe (20, incl. Russia, Ukraine, Turkey):*

- **New in 2008:** Agence National de la Recherche (France) (**C. Huber**) and Romania
- **USEMAT: annual coordination meetings in Strasbourg at E-MRS (C. Huber)**
- Support for USA-Europe Networks of materials researchers jointly with ESF
- Joint panel reviews with EPSRC-UK and DFG-Germany (at NSF and abroad)

#### *- Asia (10):*

- **New in 2008:** JST, NEDO and NIMS in Japan (**Z. Kafafi; C. Huber**)
- **US-China Workshop on Nanomaterials for Energy and Environmental Challenges (DMR-CHE-DMS): Evanston 2008; Shanghai 2009. (Z. Kafafi, C. Huber)**
- **US-Asia Materials Network: Symposium at Int. Conf. on Electronic Materials, Sydney 2008 (C. Huber); Singapore 2009**

#### *- Americas(8):*

- **Inter-American Materials Collaboration (CIAM): a multilateral joint activity**
- **Fourth CIAM Symposium/Grantees Meeting: Brazil 2008 (C. Huber)**
- NSF will host the CIAM funding and coordination meeting in April 2009





# US-China Workshop 中美論壇



## Nanostructured Materials for Global Energy & Environmental Challenges

Evanston, Illinois, September 22-24, 2008

- Held September 22-24, 2008 in Evanston, Illinois
- First in a series of bilateral US-China workshops
- Cosponsored by the NSF and the National Natural Science Foundation of China
- Two major themes: (1) Advanced Solar Cells and (2) Nanomaterials and the Environment
- Primary finding: Transformative approaches and new levels of cooperation are needed to solve global energy and environmental challenges
- Key recommendation: Establishment of a joint US-China global institute
- Next workshop on New Materials for Renewable Energy to be held in Shanghai, China in October 2009



**Three NSF (DMR, CHE, and DMS) divisions**



Zakya Kafafi, Director, Division for Materials Research gives opening remarks.



Graduate student Charusheela Raman explains her research to US and Chinese professors.

The Workshop report is available at [www.materialsworld.net](http://www.materialsworld.net)

# A Global Materials Network

## Where we are

### II. Continue to work with organizations in developing regions:

#### - *Africa (14):*

- International Materials Institutes at Princeton and UCSB supported the 2008 Africa MRS Meeting in Tanzania
- **Strengthened cooperation with North Africa: Egypt, Tunisia (Z. Kafafi)**

#### - *Southeast Asia:*

- New in 2008: Malaysia, possibly Vietnam
- **US-Asia Materials Network: Symposium at Int. Conf. on Electronic Materials, Sydney 2008 (C. Huber); Singapore 2009**

#### - *Middle East:*

- Need for follow-up on 2005 workshop in Qatar – possible cooperation with CRDF

### International Materials Institutes (IMIs) Competition in FY2008

Goal: Nucleate and coordinate international collaboration via personnel exchanges, international fellowships, seed funding, summer schools, workshops, etc..

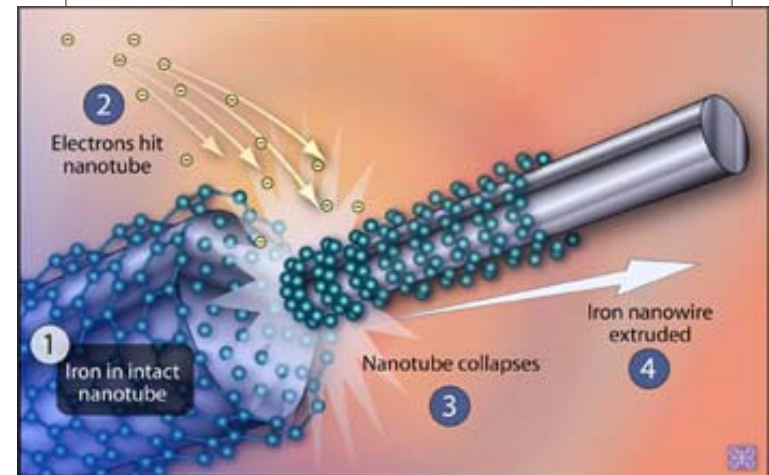
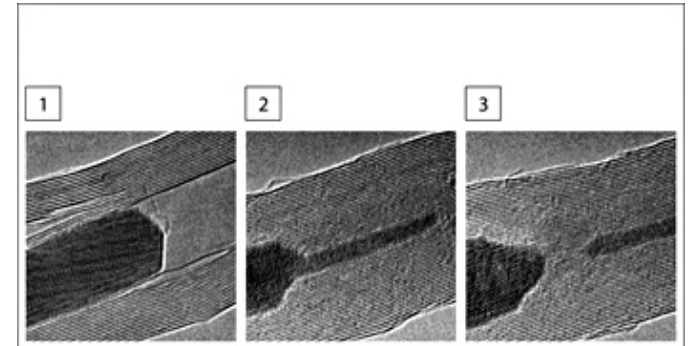




# A Global Materials Network

## Where we are going

- A materials network that links all talent available, regardless of geographical location
- IMIs evolve into US-based nodes of the network
- Seamless flow of people, information, materials, etc., through the network
- More and better utilization of cyber infrastructure in support and as a result of the network
- International research experiences as an integral part of undergraduate and graduate student's education



*Carbon Nanotubes as High Pressure Nanocylinders and Nanoextruders.* F. Banhart (Germany), P. Ajayan (RPI), M. Terrones (Mexico) et al, *Science*, May 2006



# Partnerships for International Research & Education (PIRE)

➤ Program solicitation: *NSF 09-505*

➤ Objectives

- Research excellence via international partnership – international is essential and drives the research!
- Development of a diverse, globally engaged U.S. S&E workforce
- Strengthened international engagement by U.S. institutions

➤ Five year awards, No budget ceiling

- Request the amount needed to achieve project goals
- OISE's PIRE budget for FY10-14 is \$40,000,000 in total

➤ Two-stage process

- Preliminary proposals due Feb 26, 2009
- Invited full proposals (50-70) due Aug 4, 2009



# Partnerships for International Research & Education (PIRE)

## ➤ Who May Apply?

- U.S. academic institutions that granted at least one Ph.D. in a science or engineering field since 2006
  - ❖ 3 preliminary proposals per institution
- Researcher may be PI, co-PI or senior personnel on no more than 1 pre-proposal

## ➤ Other Relevant Information

- 32 active PIRE awards (see PIRE webpage for details)
- Lead institutions strongly encouraged to partner with two- and four-year colleges, industry, museums, others
- PIRE Webcast – Dec 5 2:00 PM (registration details available in last week of November)

## ➤ PIRE webpage: [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=12819](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12819)



# Grant Opportunities for Academic Liaison with Industry (GOALI)

- GOALI seeks to fund transformative research that lies beyond what industry would *normally* fund
- Academic researchers submit proposals with industry partners (letter of support, added value for students, IP agreement)
- >250 active grants today; ~20 awards in DMR
- **Next submission date in DMR: Sept. 21, 2009**

# Small Business Technology Transfer Program (STTR)

## Phase I Solicitation FY-2009

- Small Business (PI) + Academic Researcher (co-PI)
- **NEW in 2009 – Multi-Functional Materials (MM)**
  - Bio-inspired Materials and Systems (BMS)
  - Materials for Energy Applications (MEA)
  - Nanostructured Materials (NM)
  - Smart Materials and Structures (SMS)
- Successful proposers will conduct R&D that:
  - Provide evidence of commercially viable product, process, device, or system + Meet important social or economic need
- Projects should have high risk effort and potential commercial payback
- Projects may address research tools that meet commercial market needs or applications
- **Letter of Intent required by Jan. 14, 2009**

# DMR Sponsored Workshops in 2008/9

## Ultimate Goal

To Develop a Diversified Materials Research & Education Workforce

- Materials Science and Engineering **Gender Equity** Workshop, Adelphi, MD, May 18-20, 2008
- **Materials Science and Materials Engineering Education** Workshop, Arlington, VA, September 18-19, 2008
- Workshop on **Excellence Empowered by a Diverse Academic Workforce: Chemists, Chemical Engineers and Materials Scientists with Disabilities**, Arlington, VA, February 8-10, 2009

# **MSE Gender Equity Workshop**

**May 18-20, 2008**

**Univ. Maryland Conference Center, Adelphi, MD**

<http://www.mse.uiuc.edu/gender/index.htm>

- **Purpose:**
  - to understand key issues of gender equity in MSE departments
  - to develop strategies to foster an inclusive workplace environment
- **Topics:** current status, understanding biases, balancing work and family life, improving the workplace environment
- **Format:** invited talks, panel discussions, breakout sessions
- **Participants:** ~100 from academia, National labs, funding agencies
- **Outcome:** Report - recommendations, best practices, and follow-up

Held at the annual meeting of University Materials Council

Sponsors: NSF (DMR & ENG), DOE-BES, UMC, and

UIUC MSE department

# Materials Science and Materials Engineering Education Workshop

September 18-19, 2008

Holiday Inn-Ballston, Arlington, VA

[http://www.chem.wisc.edu/2008\\_nsf\\_workshop/](http://www.chem.wisc.edu/2008_nsf_workshop/)

- **Purpose:** to bring together materials researchers and educators to begin discussion on the future of MSE education
- **Outcome:** Report and recommendations for MSE education at all levels
  - Public: know the audience, learn public understanding of S&T
  - K-12: teach the teachers, convey societal and economic benefits
  - u/g: reconsider curriculum, skill sets for tomorrow's workforce
  - Grad: programs with holistic view of research, soft skills for workplace

Sponsored by NSF – MPS & EHR (DMR, PHY, OMA, DUE, DRL)

**Workshop on Excellence empowered by a Diverse Academic  
Workforce: Chemists, Chemical Engineers, and Materials  
Scientists with Disabilities**

**February 8-10, 2009**

**Double Tree Hotel Crystal City-National Airport, Arlington, VA**

- **Purpose:** to facilitate the efforts of scientists and engineers with disabilities in research and education
- **Topics:** advances in research on disabilities education, mentorship, legal obligations, funding opportunities
- **Anticipated Outcome:** report; ways to increase successful participation of persons with disabilities in research and education

Sponsored by NSF (CHE, DMR, OMA, ENG/CBET) and NIH